THE ART OF

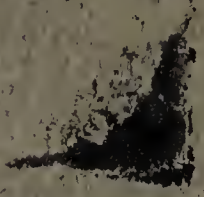
FORECASTING WHEAT PRICES

By the Use of

HARMONIC CYCLES

By Prof. L. H. Weston
Brightwood Station, Washington, D. C.

Price $5



LIBRARY

OF THE

UNITED STATES
DEPARTMENT OF AGRICULTURE

Class .....

Book .....

8—1577

Forecasting Wheat Prices

By the Use of Harmonic Cycles.

By L. H. WESTON,
Brightwood Station, Washington, D. C.

Numerous attempts have been made during the past century to find a fairly reliable method for determining, long in advance, the probable price of wheat and grain in general. In these endeavors the latest, and perhaps the most popular, has been the so-called "statistical" method in which masses of supposedly economical statistics are gathered, compiled and arranged for easy reference. The supposition is that by referring to such statistics it is possible to draw a fair inference as to what may be expected in the near future. True, no very brilliant successes seem to have been, as yet, made along the lines of such statistical methods, but yet it is certain that a considerable number of rather heavy operators in grain spend many thousands of dollars, much time and a great deal of thought in the work of securing statistics of this sort, especially regarding the crop conditions, the crop weather and the like. The United States government also maintains a statistical department the work of which is generally available, after a long a time, to all those who proceed by the "statistical method," so that in these modern times a very considerable number of market

traders, grain dealers and agriculturists give much time and attention to that method.

But lately it has begun to dawn upon the students of economics that the "statistical method" is not quite all that could be desired for the purposes of formulating conjectures as to future crop returns, prices and conditions. The method has its limitations, its draw-backs and its faults. In the first place, it is exceedingly expensive, consumes great amounts of time and labor, does not readily lend itself to the unskilled hand, indeed, it is well nigh past the comprehension of those not well trained in the art of drawing inferences from such masses of information. As a theory it promises much, but in practice it is found too unwieldy and in most cases nearly barren of results under the most favorable conditions and in expert hands.

This paucity of results in the method of simple induction, as applied to a great mass of disjointed statistics, has become so palpable that the students, the traders and those interested in the art of economical prognostics have begun to turn their attention to certain special methods that seem to offer greater advantages, particularly in the way of simplicity, elegance and general usefulness.

Among the most promising of the various methods of conjecturing the movements of wheat prices to which attention is now being turned is the old and well-known method of using recurring cycles. The "cycle" method, as its name indicates, is a method of using certain cycles in prices which are presumed to recur from time to time throughout history and which are assumed

to continue in like fashion for some time in the future.

Obviously, such a method, if found to be practical, must be of the very greatest utility in the business of forecasting, for there would be nothing easier than to try it on the records of the past, showing to absolute demonstration, in a single moment, the whole of its merits, and demerits. Then, by the simple projection of the cycle into futurity, a plan which undoubtedly would suggest itself to anyone, a fair and reasonable estimate would be possible for such future dates, taking the cycle so projected as a guide.

We have a wheat record that runs back, upon unimpeachable authority, for several hundred years, the one given in this booklet beginning in the year 1270 and running up to present time. with years as the unit of time, and it would indeed be strange if, with such a record, we could not pick out the useful cycles in it, providing any such cycles really do exist.

Now, whether or not a useful cycle can be discerned in the wheat record curve is of course a positive matter of fact. That is, it must be there, or else it must not be there. If it is there, then it becomes our business, if not our bounden duty, to look for it, and if we actually find any such a cycle or cycles in the wheat record the affirmative becomes established and we may proceed to develop and use what is so found.

Many writers have treated upon the subject of the cycles supposed to be discernable in the record of wheat prices, and we find the English astronomer Carrington mentioning them in his monumental work on Sunspots published in

1850. Later, Prof. Jevons, of England, claimed to have discovered that the prices of wheat in India changed in a periodic time exactly commensurate with the orbital period of the planet Jupiter, namely, about 11.867 years. Another writer, from England, thought he could show that the curve was a complex one having components of about 15 years and also 3 or 4 years. As a matter of fact, this line of study has engaged the attention of numerous writers on economics for many years, and therefore the tables, diagrams and demonstrations which I give in these pages will not only be later, but will be a grand improvement, as I believe, over anything ever before published on the subject.

In the following pages I give the recorded mean price of wheat for each year in England from the year 1270 to 1909, in both a table and a diagram. Also, in a diagram, the monthly mean price of wheat at Chicago and Cincinnati from 1844 to present date. Special charts also given to illustrate the explanations regarding the method of forecasting by menas of cycles.

By means of these tables and charts I show in this work how a forecast of the wheat market can be made up for over 40 years In fact, I chart the forecast in advance over 10 years, for the benefit of readers and students. It is done just as proposed above, namely, by first proving that the harmonic cylces really do exist in the records, and then carrying them on into future years. The calendar year is used as the unit of time (or the calendar month) and therefore the forecasting, as taught, is necessarily of the long swing movements.

THE WHEAT RECORD.

We have a very good record of the annual mean price of wheat in England from the year 1270 to present date. The authority from which I copy is mainly T. H. Baker ("Records of the Seasons, Prices of Agricultural Produce and Phenomena Observed in the British Isles." Printed about the year 1884, London.)

There is some record before 1257, but that appears to be about as far back as Adam Smith was able to secure reliable data. It was also found that Rogers does not give continuous records further back than the year 1259, and therefore it was deemed inexpedient to begin any continuous record earlier than the year 1270. To be sure, Adam Smith did investigate the records back to the year 1202, and we find that Holinshed states that in the year 1190 "a quarter of wheat was sold at 18s 8d, no small price then." But the records become too fragmentary for those early dates and not useful for the purposes which we have in view.

From the year 1270 to 1594 the wheat record may be considered perfectly well authenticated, and it rests mainly upon the authority of Rogers. From 1583 to 1593 there is an interim of ten years in which the values are not positively certain, except that we know in 1588 the mean price of wheat was 14s 3d per quarter and that it was much higher in 1584. After 1594 there is no question regarding the record, it is certainly correct.

There is some slight discrepancy with regard to the volume of the standard measure used, namely, the English quarter. The quarter is

really supposed to be 8 bushels of wheat and it is supposed to be heaping up in the vessel used for measuring. The quarter is also supposed to be the average volume and weight of wheat for one horse to carry, in sacks, upon its back. It seems that for all records preceding the year 1594 an English quarter was equal to 8 modern bushels "heaped up." After 1594 Adam Smith used a quarter the volume of which was 9 bushels. Then, beginning with the year 1771 the "official returns" used a quarter containing 8.252 bushels, which was supposed to be about the same as the "heaped up" quarter of the Middle Ages. Therefore, in this record, we have:

1270 to 1594—Rogers; qr of 8 heaped bushels.
1594 to 1771—Adam Smith; qr of 9 bushels.
1771 to 1909—Official; qr of 8.252 bushels.

As a matter of fact, the volumes are nearly the same, except that Adam Smith's volume is rather the greatest and he has therefore, so it appears, increased all his values by somewhere near one-eighth. The difference induced by his use of greater volume and greater value will not, however, make any great difference in comparing cycles, because the difference can only appear at points where the other records join that of Smith, and at those points they make so little difference that they may be neglected without appreciable error.

In the year 1545, during the reign of Henry VIII, the currency was debased, by a process of inflation, to such an extent that all prices, when quoted in shillings as the standard, arose to a level about nine or ten times higher than the average for the century that preceded. This

cause at once lifted the wheat curve into new high levels, where it has ben maintained ever since. The average before the year 1545 was something like 5s 7d per quarter for wheat in England, but in all time after that year the average is considered to be something like 53 shillings. In the last 60 years, however, this average has been reduced to somewhere about 45s.

It has been supposed that the English wheat record was unreliable for the reason that in former times prices were greatly modified by repeated imperial edicts, but it has been found that as a general thing the various imperial edicts that were promulgated were more in the nature of effects, themselves, than of causes. We do not find that the edicts acted very strongly to change the prices, unless it may be supposed that in a general way they merely shifted the levels slightly, leaving no evidence that they caused a difference in the regularity of variation.

In 1700, which was a year of great plenty, all duties on the exportation of wheat were removed by imperial edict (11 and 12 William III), and the price of wheat that year fell to below 29s, but in 1704, after two years of drouth, the price was up to above 47s Tooke says that on Lady-Day (March 25) in the year 1704, wheat was double that which it had been in the preceding spring. But in 1705 and 1706 there were big crops and Tovey says wheat went below 23s. Then in 1709 and 1710 there were almost total crop failures and wheat rose in price to above 78s. Thus we see that imperial edict makes no difference, one way or the other, in comparison to the effects of crop conditions. An imperial edict, so far from being an efficient cause of

price change, is nothing more than a mere effect of the times, an incident to the conditions prevailing.

THE CYCLES.

That there are recurring cycles of movement in nearly all, if not, indeed, absolutely all natural phenomena, there is now no longer any reasonable doubt. No scholar of the day, no scientist, no investigator of these times, would for a moment argue against this well established fact. The proof is not only complete and conclusive that nearly all phenomenal movement is in recurring cycles, but it has been shown that such movements are regular, smooth, symmetrical and harmonic. So certainly and so exactly is this the case that the scientists find it easy to graphically represent the motion by means of a simple algebraical expression, usually in the form of $Y = \cos x$. The ocean tides are computed by means of equations developed from this simple expression of relation in geometry. Fourier, Schuster, and others, have written books upon the subject, showing to absolute demonstration that nearly all cycles in nature are representable in terms of the cosine curves.

In fine, among the scientists of our time it is known that natural phenomenal cycles are almost always representable in composites of cosine curves superimposed upon each other through algebraical equations in the form of a Fourier sequence.

The mathematical discussion of the harmonic cycles can not be attempted here, as it would

lead into fields so broad as to be beyond the scope of a short essay on the wheat curve, but students who wish to go deeply into such matters may do so by the aid of the mathematical works published for that purpose.

It must suffice for me here to say that, since the changes in the price of wheat are due almost wholly to natural causes, the wheat market curve, when plotted on paper in the usual way, becomes a composite cosine curve, resolveable into its component parts by the application of the common harmonic analysis as used by the best scientists of our day in the work of investigating similar phenomena. Then, of course, as a necessary corellary to this, we may synthetically combine these harmonics, under correctly formulated and evaluated equations, thus projecting the curve to any desired extent into all future dates desirable.

How this is to be done with regard to the wheat curve will be explained herein, but even without this explanation as regards the harmonics, the student will have no trouble in securing satisfactory results by means of the very simple devices given herein, as based upon such harmonic analysis.

FINDING THE CYCLES AND EPOCHS.

In looking for recurring cycles in the price movement of wheat the first requisite will be the diagramed, or charted, record. This is because a diagram or chart most readily lends itself to clear, comprehensive and open inspection. The long record of wheat prices as given

herein is expressed in English shillings and pence, 12 pence being equal to one shilling. The calendar year is the unit of time. We then proceed, in the usual way, to chart the prices of the table, thereby producing the wheat curve, supposed to be the representative curve of natural phenomenal movement in prices, and, as such, must be a composite of cosine values spaced by cycles from points of epochs.

Referring, now, to this chart, we perceive, at about the first glance, that along near the year 1812 a very prominent and notable top appears. This will suit us very well as a starting point in our search for cycles, because it is in the modern times and is unmistakably a true top. Taking another glance on down the curve we notice that in the year 1322 there is a pretty stiff top and as it comes out some time back in the Middle Ages it ought to be far enough back to give us a few cycles in between. The difference between 1322 and 1812 is 490 years, and upon looking for other tops in between we come to find out there must be something like 8 to 12 of them, or, let us say, on the averagt, ten of them, sufficiently prominent as to merit more than ordinary attenion. Seeing this, the conclusion becomes irresistable that a cycle may be found just 49 years long, for 490 divided by 10 will be 49 years even.

This puts us in mind of the famous jubilee cycle of the ancient Jews, which was 49 years in length. We also call to mind that he Jew used a 7-year cycle, which is, of course, the 7th harmonic of the jubilee cycle of 49 years. Furthermore, the ancient jubilee cycle had direct-

reference to land values, crops, and undoubtedly the price of wheat, as a consequence. This is to be found in the 25th chapter of Leviticus.

Upon gathering the idea that in this chart of the wheat curve there might be found a cycle of 49 years with its seventh harmonic superimposed upon it to represent the shorter swings which we see occur in the diagram, our next step will be to make a test of the case.

In order, then, to settle somewhat more definitely just about what the 49-year cycle does contain in the way of shorter harmonics, we take the record out in sections of 49 years, beginning with the year 1812 as a starting point, or radical epoch. This plan will result in the record being cut up into short sections, that is, 49 year cycles, beginning with these years:

1273 1322 1371 1420 1469 1518 1567
1616 1665 1714 1763 1812 1861 1910 1959 2008

A well known process in statistical investigation is that of averaging, that is, algebraically adding together a considerable number of cycles in the record, all of the same length, in order to get their average value, because such average will fairly represent the cycle as measured from any of its epochs. Also, if there is a permanent harmonic within such cycls it will very likely appear as an harmonic component of the curve, all brought out by the process of averaging. Accordingly, I have worked out the averages for the 49-year cycle of the wheat record, using the epochs as just given.

I begin with that epoch which falls out at the year 1273, because it is eleven cycles back from the radical year 1812, which has been chosen for

reasons before mentioned. I then combine the six cycles following that year in order to form a composite, or average, which shall embrace the early part of our record. Now, because there is some question regarding a few years in the cycle from 1567 to 1616 I leave that period out of all the calculations and in the next table combine five more cycles in an average thus showing the movement for the latter part of our record, and also in what may be considered the modern times. By thus leaving out the central cycle (which, however, is quite regular and in no great amount different from all the others) we get two sets of averages, one of the early movements and one of the later movements of the prices of wheat.

The first set of averages was composed of the five cycles laying between the years 1273 and 1567. Then the cycle 1567 to 1616 was left out, and the second, or modern set is from 1616 to 1910. They prove to be very similar, so nearly so that I simply combine all together in order to form the 49-year cycle and derive from it the natural harmonic which evidently inheres within it. This result is given in the Composite Chart of the 49-year cycle, and it is the one used as the basis of all forecasting.

If we examine the composite chart with some attention we will find that there are just about eight places where tops come out and likewise there are eight bottoms. Eight into 49 goes 6.125 times, so it seems very much as though the famous 7-year cycle of the ancient Jews was in reality about six and one-eighth years instead of 7. It is the eighth harmonic that gives the best results in the 49-year cycle, instead of the

seventh. This is easily seen when we come to lay this composite down on the record. In the record we have 13 complete cycles, beginning with the year 1273, and we find this composite falls in very well, though not perfectly, of course, in every one of them, and perfect conformity is hardly to be expected. There are irregularities in the record from several outside causes, and, furthermore, our averages may not be perfect, yet it is quite plain that even as we have them they would serve very well for forecasting purposes. It beats guessing at the problem, and, being strictly scientific, it is far and away superior to any other method yet devised for reaching estimates as to the probable prices of wheat in future years.

In the chart of the composite page 26, notice that a top comes out at the 45th year, while absolute bottom is at the 24th year, thus showing that the curve for 49 years is not regular but runs smoothly down about 28 years and then rises 21 years and thus repeats indefinitely. This is because upon this smooth 49-year curve is fixed its eighth harmonic of 6.125 years, and if we assume that in the 45th year the true top is permanently located then upon going back six years each time we should have tops distributed in the whole cycle of 49 years nearly as follows: Maximums at 45, 39, 33, 27, 21, 15, 9, 2 and then 45 again and so on forever. We see by the chart of the averages that this is the distribution, very nearly. To place the minimums we add 4 to the first one and 3 to every other maximum and it gives all the minimums very well in the following order, going back : Minimums are at 48, 42, 36, 30, 24, 18, 12, 6, then 48 and so on. Page 26.

It is true that the demonstration does not give perfect results, but they are so close that we would be in great error if we rejected them just because we could not get absolute apple-pie order out of them.

After a great number of trials and experiments I found that these figures as I give them, with the epochs as in the table, will afford the best criterion that we can derive for forecasting purposes. But in order to make them smooth and more available for forecasting, I have arranged the harmonics as in the Harmonic Chart and this Harmonic Chart will be considered as the final result and the one to be used in all projections into future years. **Bottom page 26.**

The Harmonic equations for this Harmonic Chart may be written as follows (but yet I arrange the harmonics to even dates instead of trying to adjust to fractions of the year.)

$A-a = -30s \cos (t+1273)\ 7.34^\circ$ .....49 years
$+B-b = -15s \cos (t+1269)\ 58.79^\circ$ .....6.125 years

In this equation A is the 49-year cycle in the form of a cosine curve of 49 units, while B is its 8th harmonic, permanently superimposed, as the plus symbol indicates. The s means English shillings, or merely whole numbers. The t is time from the epoch counted in calendar years. Component A begins with the year 1273; B with 1269. The graphic solution of this equation is given in the dotted curve on page 26, and the numerical values are in the table on page 27, wherein is also shown the values for the record composite from which it is derived. Both are diagramed together on page 26. This harmonic is useed to form the long-swing forecast.

It is the scientific theory, and our adopted doctrinal, that the influences which cause variations in wheat prices proceed, in time, along a path which when plotted in the usual way on paper, is approximately a cosine curve.

RECORD of the mean price of wheat in England each year from 1270 to 1909. Price is shillings and tenths of a shilling per English quarter of about 8.252 bushels.

	0	1	2	3	4	5	6	7	8	9
127	6.4	10.0	6.4	5.5	6.8	5.1	6.3	5.2	4.5	5.1
128	5.0	6.1	6.0	7.0	5.0	5.4	4.6	2.8	3.1	4.4
129	6.4	5.6	5.4	8.3	16.0	6.8	4.8	5.2	5.2	5.8
130	4.8	5.0	5.0	4.1	5.8	4.9	4.0	5.8	6.9	7.2
131	7.1	4.5	4.9	5.6	8.4	14.9	16.0	39.5	4.6	5.8
132	6.4	11.8	9.0	8.5	7.4	5.7	3.7	3.9	6.4	6.6
133	7.2	7.9	4.8	4.2	4.0	5.4	4.9	3.6	3.0	5.9
134	3.7	3.8	4.2	5.7	3.5	3.8	6.9	6.6	4.2	5.5
135	8.3	10.3	7.2	4.3	5.4	5.9	6.0	6.8	5.6	5.9
136	6.4	5.5	7.6	8.5	7.6	6.0	6.8	8.7	6.7	11.9
137	9.4	7.0	7.8	6.2	8.2	7.8	4.9	3.9	3.7	5.8
138	6.3	5.6	5.3	4.8	5.6	5.1	4.1	3.4	3.7	5.4
139	8.8	5.5	3.2	3.8	3.9	5.0	6.0	5.8	5.3	5.5
140	7.9	7.5	6.8	4.9	4.0	3.8	4.4	4.6	7.3	9.0
141	4.9	4.8	4.9	4.3	4.4	6.4	8.0	5.4	7.0	4.8
142	6.3	5.3	4.4	4.5	5.0	4.0	3.9	4.4	8.9	7.9
143	5.9	4.7	6.9	5.8	5.5	5.5	5.4	9.4	14.7	7.7
144	3.9	4.0	3.9	4.2	4.0	6.4	6.0	5.2	5.7	5.4
145	6.6	6.5	5.8	5.1	3.8	5.5	5.0	5.8	5.9	5.2
146	7.0	7.4	4.4	3.9	4.2	4.6	5.4	5.5	5.7	6.5
147	5.8	5.7	4.1	3.8	4.5	5.4	5.2	6.7	6.6	5.8
148	5.8	8.6	10.4	7.3	5.4	4.5	5.4	5.5	5.5	5.9
149	4.9	6.6	4.3	4.1	4.8	4.1	5.5	5.1	5.5	4.8
150	6.2	8.4	8.1	6.4	5.0	4.8	5.4	5.6	3.9	3.0
151	4.0	5.9	9.1	6.1	5.4	6.8	5.4	6.5	6.0	7.2
152	9.4	7.7	6.0	5.5	5.2	5.4	6.3	12.9	8.8	8.9
153	8.4	8.2	8.0	7.7	7.0	10.4	10.7	7.1	6.9	5.6
154	5.8	9.0	7.9	9.3	9.0	15.6	8.3	4.9	8.2	16.4
155	18.0	20.4	10.6	10.0	18.8	22.1	28.5	8.5	9.3	11.1
156	14.3	15.7	10.9	19.8	10.9	10.6	16.4	11.1	11.4	11.8
157	9.8	12.1	13.6	26.4	14.4	15.9	22.3	20.2	17.4	17.5
158	20.0	20.1	19.2	22.0	24.0	17.0	7.5	18.0	14.3	15.0
159	16.2	17.4	18.6	20.0	56.0	53.0	80.0	92.0	56.7	39.0

This table gives the yearly mean price of wheat in England. The prices are shillings and tenths of a shilling instead of in pence. The change was made in order to secure greater facility in handling the values in analytical processes. Following are the parities:

When pence are.....1 2 3 4 5 6 7 8 9 10 11
The decimal substituted is.....1 2 3 4 4 5 6 7 8 8 9

Record of wheat—Continued.

	0	1	2	3	4	5	6	7	8	9
160	36.7	34.9	29.4	35.4	30.7	35.9	33.9	36.7	56.7	50.0
161	35.9	38.7	42.4	48.7	41.8	38.7	40.4	48.7	46.7	35.4
162	30.4	30.4	58.7	52.0	48.0	52.0	49.4	36.0	28.0	42.0
163	55.7	68.0	53.4	58.0	56.0	56.0	56.7	53.0	57.4	44.9
164	44.7	48.0	68.0	67.0	70.0	69.0	48.0	73.7	85.0	80.0
165	76.6	73.4	49.5	35.5	26.7	33.4	43.0	46.7	65.0	66.0
166	56.5	70.0	74.0	57.0	40.5	49.4	36.0	36.0	40.0	44.4
167	41.7	42.0	41.0	46.7	68.7	64.7	38.0	42.0	59.0	60.0
168	45.0	46.7	44.0	40.0	44.0	46.7	34.0	25.2	46.0	30.0
169	34.7	34.0	46.7	67.7	64.0	53.0	71.0	60.0	68.4	64.0
170	40.0	37.7	29.5	36.0	46.5	30.0	26.0	28.5	41.5	78.5
171	78.0	54.0	46.4	51.0	50.4	43.0	48.0	45.7	38.8	35.0
172	37.0	37.5	36.0	34.7	37.0	48.5	46.0	42.0	54.5	46.8
173	36.5	32.8	26.7	28.4	38.9	43.0	40.4	38.0	35.5	38.0
174	50.7	46.7	34.0	24.9	24.9	27.5	39.0	34.9	37.0	37.0
175	32.5	38.5	41.9	44.7	34.7	33.9	45.3	60.0	50.0	39.9
176	36.5	30.3	39.0	40.8	46.8	54.0	48.5	53.2	60.2	45.5
177	49.0	47.2	50.7	51.0	52.7	48.4	38.2	45.5	42.0	33.7
178	35.7	44.7	47.8	52.7	48.8	51.8	38.8	41.2	45.0	51.2
179	54.8	48.6	43.0	49.3	52.3	75.2	78.6	53.8	51.8	69.0
180	‡3.8	‡9.5	69.8	58.8	62.3	89.7	79.1	75.4	81.4	97.4
181	‡6.5	95.3	‡2.5	‡9.8	74.4	65.6	78.5	96.9	86.3	74.5
182	67.8	56.1	44.6	53.4	63.9	68.5	58.7	58.5	60.4	66.3
183	64.3	66.4	58.7	52.9	46.2	39.4	48.5	55.8	64.6	70.7
184	66.4	64.4	57.3	50.1	51.3	50.8	54.7	69.8	50.5	44.3
185	40.3	38.5	40.8	53.3	72.4	74.7	69.2	56.4	44.2	43.8
186	53.3	55.4	55.4	44.8	40.2	41.8	49.9	64.4	63.8	48.2
187	46.9	56.7	57.0	58.7	55.8	45.2	46.2	56.8	46.4	43.8
188	44.4	45.4	46.8	41.6	35.7	32.9	31.0	32.5	32.5	29.7
189	31.9	37.0	30.3	26.4	22.9	23.1	26.2	30.2	34.0	25.7
190	26.9	26.1	28.1	26.8	28.4	29.7	28.3	30.6	32.0	36.9

‡ For year 1800 price is 113.8; 1801 119.5; 1811 106.5; 1812 126.5; 1813 109.8.

On account of the World War of 1914 prices of wheat in England for the decade 1910 to 1920 were unreliable for statistical purposes and for time after 1909 Chicago prices are used.

The Monthly Swings in Wheat Prices.

The record for the monthly swings in wheat prices for each calendar month of every year from 1844 to present date is given in the Monthly Chart. It is of the mean monthly price of wheat, found by adding together the highest

and the lowest price made during the month and dividing the sum by two.

The record used for making the Monthly Chart is the Cincinnati price for cash wheat from 1844 to 1857, and from 1858 to present it is the Chicago market price for cash wheat.

I give this Monthly Chart in six sections of 13 years each, because after much careful experiment I found that there is a period of just 13 years in which the monthly mean price passes through a complete cycle of change.

By adding together the five cycles of the record, beginning with the years 1844, 1857, 1870, 1883 and 1896, I derived a composite, or mean curve 13 years long, and it is supposed to be the regular forecast for any 13 year cycle, past or future, if taken from dates of epochs as given herein. This cycle I have diagramed along with the record charts, in order to show how well it works as a forecast. It is also projected into future years to serve as a guide for forecasting. For future dates the new 13-year cycle will begin with the years 1922, 1935, 1948, 1961, etc.

All modern statisticians are familiar with this method of deriving a curve for forecasting purposes and it is now considered to be strictly scientific method. But the use of it is easily tested by trying it upon the record, as I have done in the Monthly Charts, where, by mere inspection we may judge quite closely as to its merits and demerits as a forecast.

Upon making the comparisons as suggested we find that the main features of this 13-year cycle, or composite, are a fairly general regular-

ity for the first five years of it, for in those years we see tops come out in May or June, after which a heavy decline occurs, but with a rally at about the end of the year. In the sixth year the tops come in September. The ninth year appears to be a sort of transition year and it is therefore the least reliable of all, but yet there are generally two tops in it, one coming pretty early and one pretty late.

If a trader would stay on the long side up to about May in the first five years of this cycle and then sell out and go short to near the end of harvest he is likely to gain. In the sixth year, however, he looks out for the market to run on to after harvest before dropping much, and then a rally again early in the 7th year, and so on, going pretty well by the number of the year in the 13-year cycle, yet paying attention, also, to the long-swing cycle of 49 years with its harmonic of 6.125 years.

In fine, the general plan of forecasting is to assume that the price of wheat generally will be about as forecasted in the 49-year cycle, but yet the monthly movements should be attended to as forecasted by the 13-year cycle.

It is beyond the scope of this work to give the methods of forecasting the daily prices, but the student may study the movements along the lines herein suggested and he should finally succeed much better than by any other known method, and away better than by mere guessing.

It is of course to be understood that the student and investigator will make up his own charts and work out his own figures, following the guidance herein offered.

THE MONTHLY CHARTS.

The monthly charts from 1844 to 1921 inclusive are not draws to scale, as it would require a very large engraving to give so many months to actual scale. But yet the actual movement of prices is given relatively in every year.

The years, in three sections on each page of the monthly charts, with the dates given, are the record movements, while the lowermost section on each page of the monthly charts, with figures from 1 to 13, is the curve of the composite of the five 13-year cycles lying between 1844 and 1908 inclusive. Carefully notice that this composite, the figures for which are given in a table, serve as a true forecast for all years after 1908, because the record after 1908 is not worked into the composite.

Note that for every year after 1908 the forecast is pretty fair, except in the case of 1916-17 which was during war conditions. The Government controlled prices from Sept. 7, 1917, to June 1, 1920, yet even at that the forecast (the bottom curve in the monthly charts) is fair.

The Forecast.

It is, of course, perfectly plain to every reader that the composite curve at the bottom of each monthly chart in the 13-year cycle is the forecast for all time after January, 1909. But in order to make it so clear that no sort of mistake can be made regarding the use of the cycle as given, I give here the years in the future that correspond with the numbered years in it:

Table of Epochs in the 13-year Cycle.

1	2	3	4	5	6	7	8	9	10	11	12	13
1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960

Example—Let it be required that we furnish a forecast of the price of wheat for the calendar year 1925.

We first refer to the 49-year cycle and find that the year 1925 will be the 16th year in the 49-year cycle, and as a consequence we will find, upon examining that cycle as per the chart of it at the bottom and right side of page 26, that prices are on a swift decline and nearing bottom at the end of the year. We also see this in the figures of the composite as shown in the table.

Next, we go into the table of epochs for the 13-year cycle as given above, and find that it will be the 4th year of it. Then referring to No. 4 of the 13-year cycle chart, or the table, we find prices strong to February, break down some in March, but go to a top about in June, followed by a swift drop to November, but with a rally up in December and January of the next year. In this manner we get out the forecast for any number of years in advance that may be desired.

Still furthermore, in order to render it perfectly easy to handle the monthly values in the 13-year composite, I give the table complete, as reduced from my original values found by the process of averaging, as described before. This table furnishes the monthly forecasts for all future years, measured from the epochs as above.

Table of the 13-year Cycle.

These figures are charted, pages 27 and 28. They are the values to use for forecasting purposes, superimposed upon the 49-year cycle, as has been explained.

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1922	1st year	8	17	11	20	40	36	25	14	5	0	11	9
1923	2 "	15	20	17	15	25	27	0	14	16	10	17	22
1924	3 "	23	26	28	32	38	20	8	0	5	15	18	20
1925	4 "	22	30	17	30	36	44	25	23	12	10	9	23
1926	5 "	27	20	31	35	40	25	10	5	7	5	0	3
1927	6 "	9	7	14	16	20	18	31	36	40	34	25	21
1928	7 "	26	36	38	26	23	21	20	0	15	22	18	27
1929	8 "	24	15	6	25	40	38	35	34	20	14	16	9
1930	9 "	16	15	13	10	5	0	5	18	22	17	13	9
1931	10 "	11	15	18	4	20	34	22	6	15	27	36	38
1932	11 "	22	27	20	32	44	25	9	11	15	3	10	18
1933	12 "	21	25	32	40	35	39	10	21	16	33	37	31
1934	13 "	36	20	17	6	21	36	30	20	12	4	0	7

Concluding Remarks.

On page 27 is given the table of composite and harmonic values in the 49-year cycle. That composite is, as before stated, the result of eleven cycles added together, while the harmonic values are merely the smoothed curve of this same composite, and both are charted together on page 26. As a scientific principle we assume that the harmonic will give best results in forecasting, but of course the composite might be adhered to if the student prefers the natural composite. The range given in this booklet is arbitrarily 36, as there appeared to be no necessity for using larger figures, but any experimenter may easily change the range to suit his own purpose.

No true harmonic for the 13-year cycle was worked out, although it is just possible that a useful harmonic might be found in it when longer records become available in later years. It seems probable that 13 years is not of itself a true cycle, the real cycle being $49 \div 4 = 12{,}125$ yrs. But a rather singular thing is that the period seems to contain just 13 even units, that is, calendar years, so that the fraction actually counts as a year, in the present era. That is, it seems as though there were but 13 different kinds of movement in the years, and even these are generally upward from October to May and then down to October again. This is indicated by the first five years.

MONTHLY RECORD CHICAGO WHEAT

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
1844	75	77	75	75	69	60	59	68	70	66	70	70	69
1845	74	75	75	75	74	75	62	53	52	64	75	85	70
1846	75	73	80	65	56	50	45	48	52	63	68	58	60
1847	62	80	75	87	92	105	75	73	75	84	86	102	83
1848	94	83	90	90	88	75	62	64	75	74	75	75	78
1849	75	75	75	69	71	77	80	87	86	83	70	80	78
1850	90	92	92	95	98	110	98	75	70	70	68	75	86
1851	76	72	67	71	70	70	64	69	59	59	58	58	66
1852	59	59	62	62	61	63	62	59	60	60	66	75	62
1853	80	77	75	75	74	84	80	80	88	96	104	102	89
1854	114	133	125	131	160	141	104	131	142	132	146	158	134
1855	160	163	167	192	192	174	112	125	122	148	167	156	156
1856	141	131	116	110	112	100	102	111	113	116	110	111	114
1857	114	115	112	110	140	140	127	109	89	79	80	‡73	107
1858	‡56	55	62	63	62	67	64	87	76	66	61	65	71
1859	81	87	92	83	104	83	63	61	73	80	86	93	83
1860	98	99	101	105	106	103	99	84	86	82	78	74	90
1861	76	75	78	95	108	64	61	71	67	71	66	65	84
1862	67	72	72	72	70	72	81	86	81	86	77	84	77
1863	95	108	108	102	96	95	92	85	97	108	105	109	97
1864	110	112	109	120	122	176	200	192	183	159	174	152	105
1865	141	124	115	103	105	106	108	120	124	123	122	93	118
1866	84	82	92	96	117	120	106	139	179	186	189	187	136
1867	145	190	207	243	267	207	188	173	177	189	177	180	206
1868	149	200	196	202	200	198	195	174	154	126	112	100	151
1869	114	116	112	108	112	119	129	137	123	106	89	85	112
1870	80	82	77	84	100	110	117	109	99	105	103	105	92
1871	120	125	126	127	128	129	120	112	120	118	120	119	120
1872	123	125	117	128	148	138	126	136	123	114	106	116	128
1873	123	124	120	119	128	123	120	132	105	102	100	112	116
1874	122	119	120	124	123	120	113	102	98	92	88	90	106
1875	89	86	92	99	98	96	120	123	112	110	109	99	104
1876	99	102	102	100	102	105	94	90	102	110	112	120	105
1877	127	126	125	150	159	148	138	115	112	110	109	108	134
1878	105	106	108	109	106	94	99	98	88	83	83	84	96
1879	84	90	92	87	97	104	96	86	96	113	116	129	107

The yearly price movements as in this table are charted on page 26 and a forecast for Chicago wheat is projected to the year 1962.

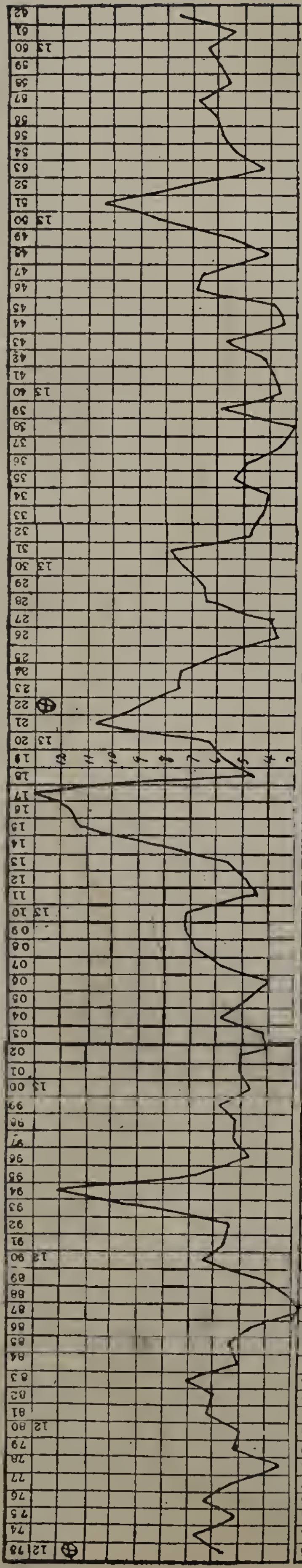
‡ The Cincinnati record ends Dec. 1857, and Chicago record begins Jan. 1858. Prices are mean of the month.

MONTHLY RECORD CHICAGO WHEAT

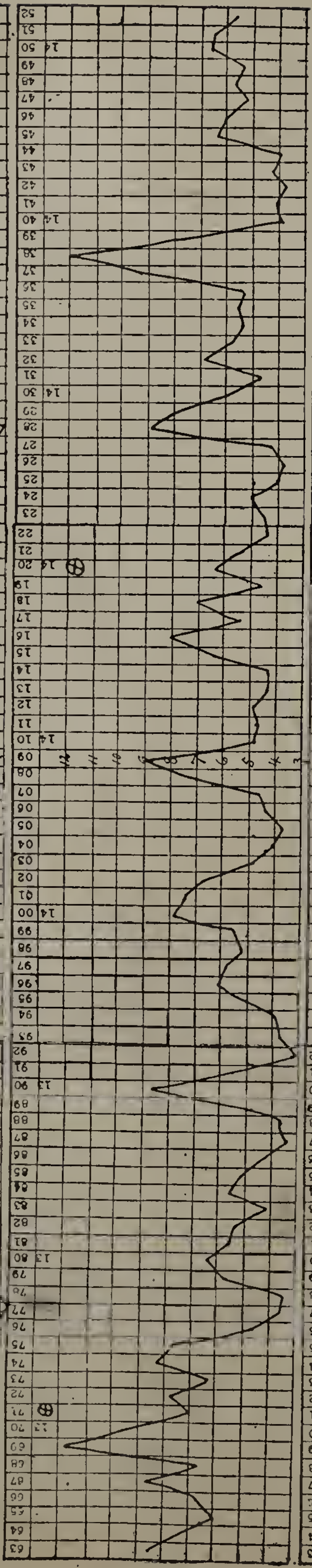
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
1880	123	122	119	110	116	95	92	88	92	97	107	102	106
1881	93	98	101	103	107	111	116	129	131	137	128	127	115
1882	130	124	129	137	126	130	131	103	102	95	93	92	116
1883	98	108	107	106	111	106	100	102	96	93	95	97	102
1884	92	94	87	85	90	87	82	80	77	72	73	72	83
1885	79	77	76	85	88	87	88	84	82	88	90	86	82
1886	81	80	78	77	76	74	76	77	76	72	75	78	77
1887	79	75	76	80	85	80	70	68	69	71	74	77	76
1888	77	75	74	76	85	82	82	88	127	110	109	102	101
1889	97	101	100	89	82	79	81	77	79	80	80	78	89
1890	76	75	79	84	96	89	90	99	100	99	95	91	88
1891	92	95	99	107	104	97	90	100	95	96	94	92	99
1892	87	88	84	81	83	83	78	77	73	72	71	71	80
1893	75	74	76	79	72	65	60	59	66	63	61	62	70
1894	61	57	58	61	56	57	55	54	53	51	54	55	56
1895	51	50	54	59	71	75	66	64	59	60	57	56	63
1896	62	66	65	66	62	60	58	58	63	73	83	84	71
1897	77	75	74	72	73	70	74	88	93	90	92	96	83
1898	99	102	103	112	151	95	77	70	67	66	67	66	109
1899	72	72	70	73	74	75	72	72	73	72	68	66	71
1900	64	66	65	66	66	77	78	74	76	74	72	72	71
1901	74	73	75	72	73	71	67	71	75	69	71	76	73
1902	77	75	73	74	75	74	75	72	83	73	74	75	77
1903	75	77	73	75	78	80	79	84	84	82	81	82	79
1904	87	98	96	94	97	104	103	107	114	116	115	114	102
1905	118	119	115	103	100	107	103	97	86	87	88	86	103
1906	86	83	80	85	88	86	79	70	74	72	73	74	79
1907	73	80	79	81	93	96	98	94	97	107	93	102	90
1908	97	94	100	98	105	100	102	107	101	103	115	108	105
1909	107	116	120	132	140	144	123	118	108	113	112	117	126
1910	219	120	119	114	110	106	114	115	106	103	99	100	110
1911	102	97	93	94	98	95	96	101	100	106	102	101	100
1912	103	105	107	111	116	113	107	101	99	101	96	98	106
1913	102	101	97	100	100	99	90	89	92	91	53	94	96
1914	93	94	93	93	96	89	94	106	117	110	115	122	106
1915	140	157	151	158	149	130	132	120	109	110	109	117	133
1916	129	124	114	122	116	108	118	143	156	179	183	166	146
1917	185	178	193	200	301	267	255	256	224	218	218	218	240
1918	218	218	218	218	218	218	227	228	226	225	226	232	224
1919	234	229	240	266	262	239	245	239	353	249	273	294	262
1920	300	254	262	284	313	293	264	252	254	217	191	186	250
1921	186	178	168	141	162	154	149	135	143	126	117	123	155
1922	118	135	138	140	136	120	116	105	109	116	126	131	123

The yearly price movements as in this table are charted on page 26 and a [illegible] for Chicago wheat is projected to the year 1962.

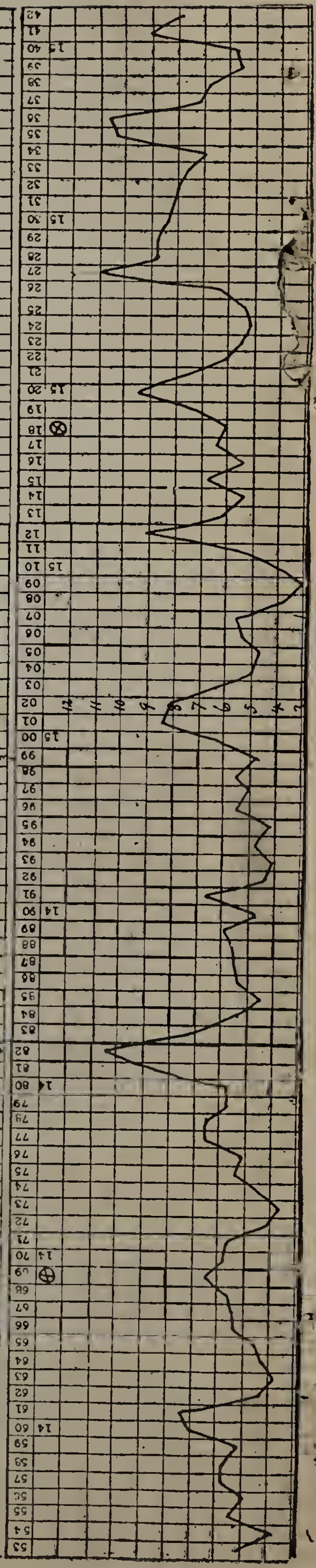
1273 to 1362



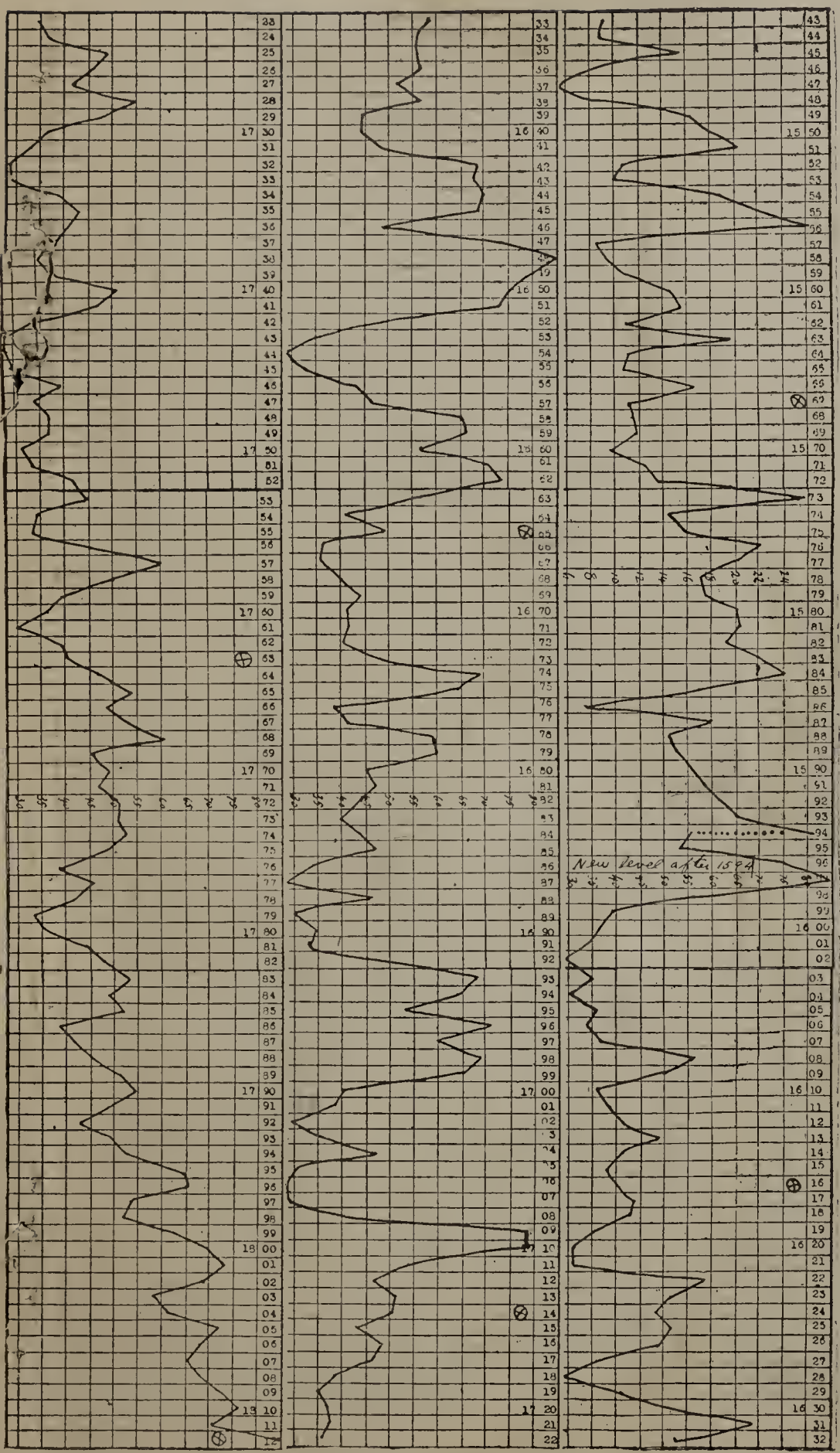
1363 to 1452

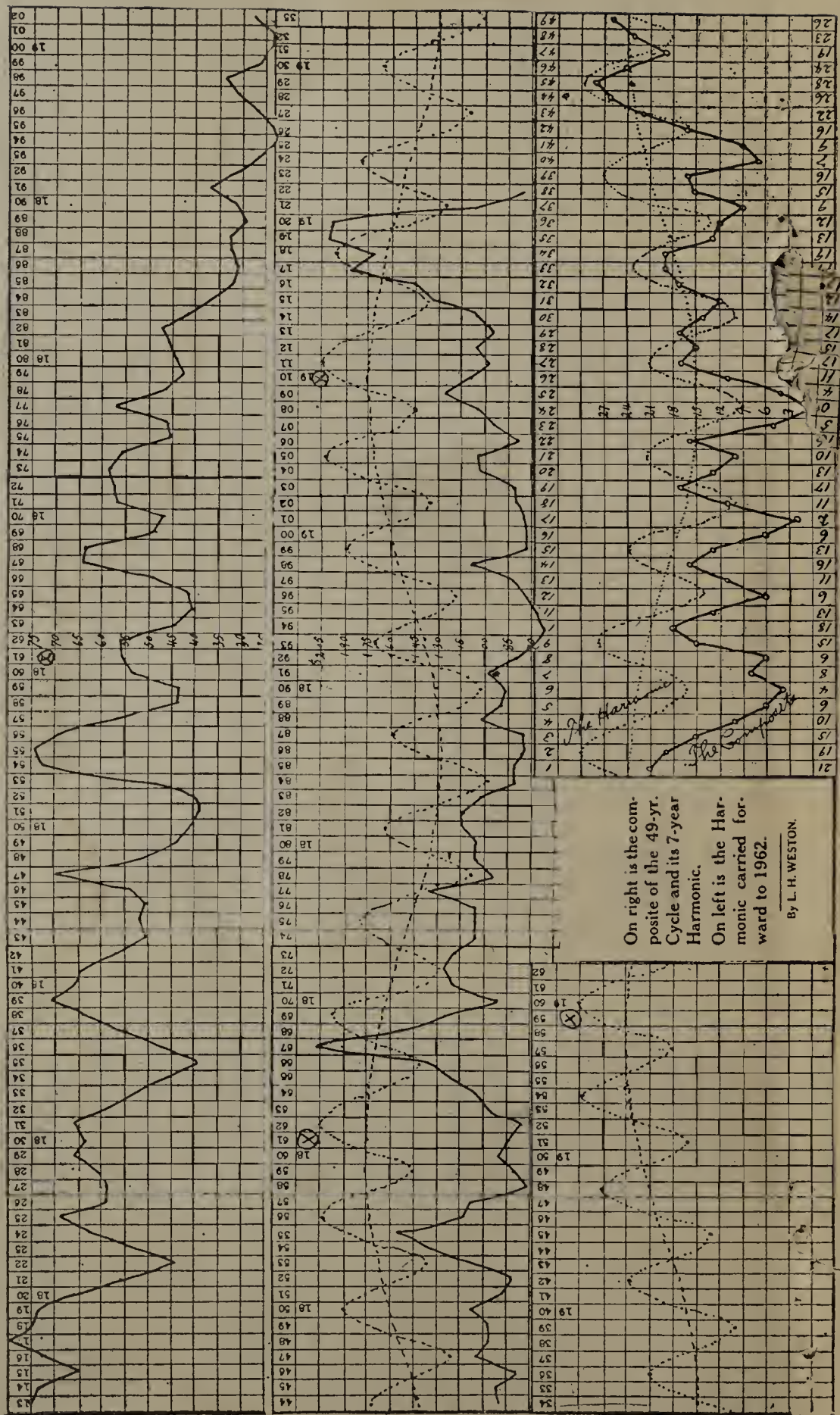


1453 to 1542



1723 to 1812 1633 to 1722 1543 to 1632





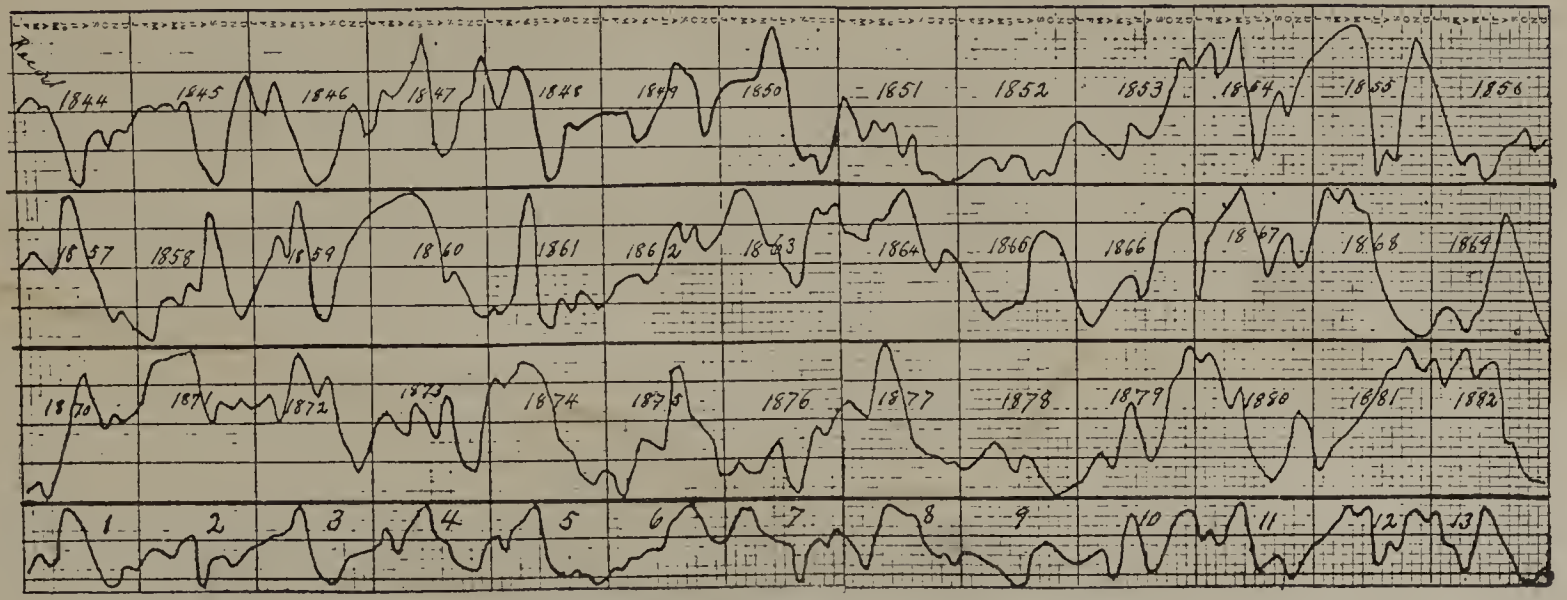
On right is the composite of the 49-yr. Cycle and its 7-year Harmonic.
On left is the Harmonic carried forward to 1962.

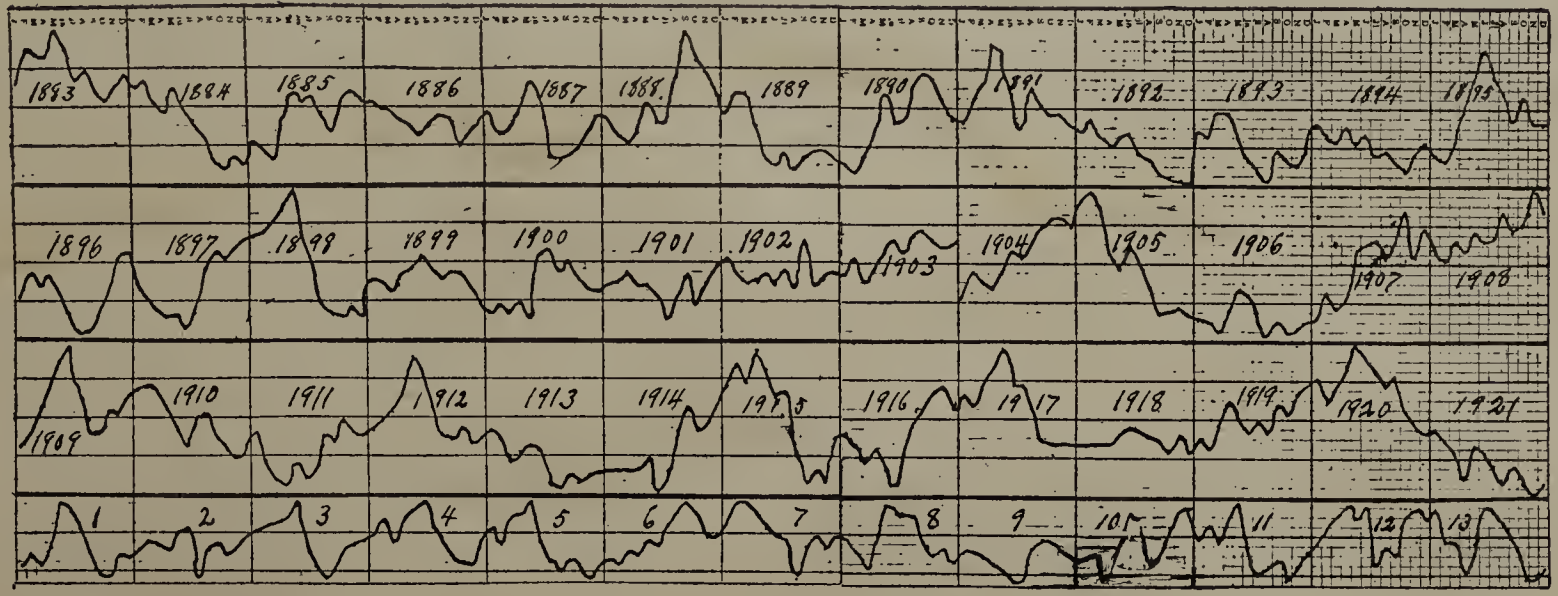
By L. H. WESTON.

1813 to 1902 Chicago Wheat Forecast

This is the 49-year Composite of eleven cycles, with its Harmonic. The Harmonic values are the ones to use in forecasting the long-swing in wheat prices.

Year No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Composite	21	19	15	10	6	4	8	6	15	18	13	6	11	16	13	6	2	11	17	13	10	16	5	0	4	11	17	15	17	14	12	17	19	19	13	12	9	15	16	7	9	16	22	26	28	24	19	23	26
Harmonic	29	33	30	23	16	10	14	25	30	28	17	7	12	23	25	20	7	4	7	16	19	16	8	0	5	13	20	18	10	4	6	16	24	20	13	7	18	26	30	26	17	11	23	31	36	32	23	16	24





In order to get the Chicago and Cincinnati wheat records within some reasonable range for diagraming 20 cents has been added to each yearly price from 1844 to 1853, and in all years after 1916 50 cents has been subtracted. This is done only in the charts, not in the record table, as that table gives the true record of authority. It is merely a handy device used in charting, in order to save space in printing.

The student may make up his own charts from the table given herein, for each table gives the actual record as copied from the authors.